Computer Aided Modeling and Equipment Evaluation (CAMELEON)
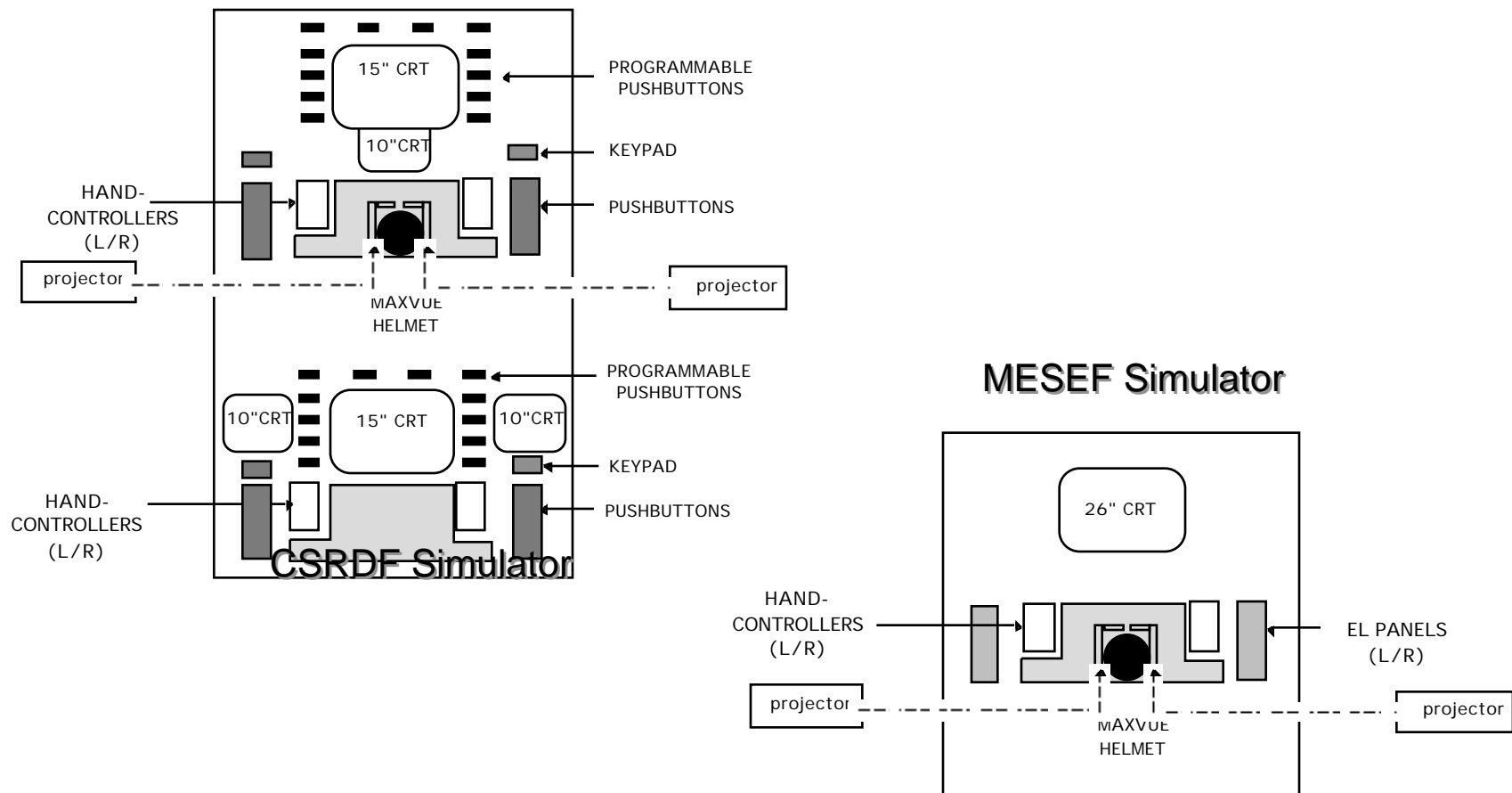
Dr. Nancy Bucher, US Army Aviation Systems Command
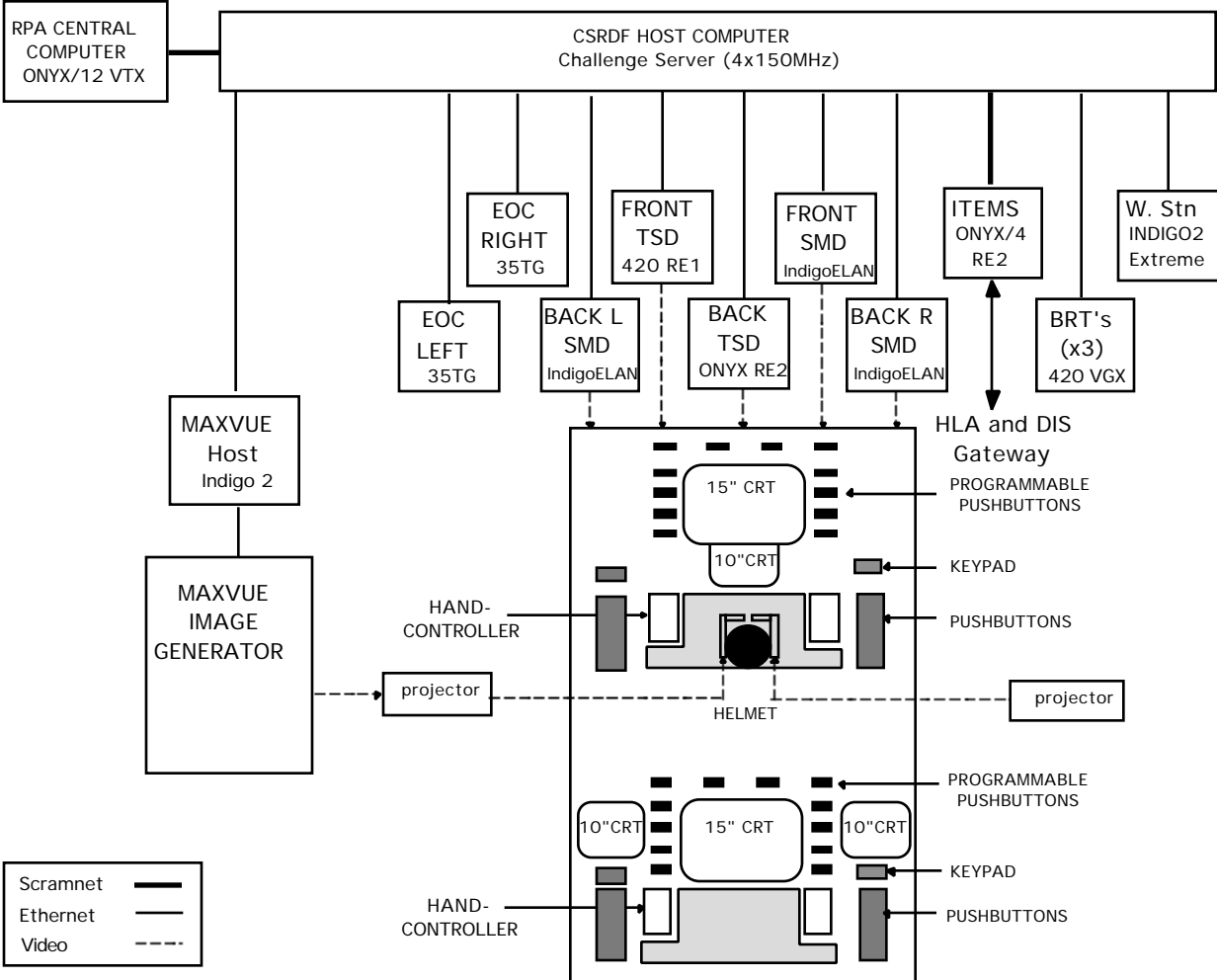
9 October 1997

AMSIM Overview

- **AMSIM is a US Army full-mission rotorcraft simulation facility located at Moffett Field, CA**

- **Primary areas of research:**

  - **Pilot-vehicle interfaces for the next generation Mission Equipment Packages (MEP)**

  - **Virtual prototyping in a simulated tactical environment**

- **Flight environment is designed to support low altitude and Nap-of-the-Earth (NOE) mission scenarios associated with scout/ attack rotorcraft**

AMSIM Simulators

15" CRT

PROGRAMMABLE
PUSHBUTTONS

10"CRT

KEYPAD

HAND-
CONTROLLERS
(L/R)

PUSHBUTTONS

projector

projector

MAXVUE
HELMET

PROGRAMMABLE
PUSHBUTTONS

MESEF Simulator

10"CRT

15" CRT

10"CRT

KEYPAD

HAND-
CONTROLLERS
(L/R)

PUSHBUTTONS

26" CRT

CSRDF Simulator

HAND-
CONTROLLERS
(L/R)

EL PANELS
(L/R)

projector

projector

MAXVUE
HELMET

CSRDF Architecture

RPA CENTRAL COMPUTER ONYX/12 VTX

CSRDF HOST COMPUTER
Challenge Server (4x150MHz)

EOC RIGHT 35TG

FRONT TSD 420 RE1

FRONT SMD IndigoELAN

ITEMS ONYX/4 RE2

W. Stn INDIGO2 Extreme

EOC LEFT 35TG

BACK L SMD IndigoELAN

BACK TSD ONYX RE2

BACK R SMD IndigoELAN

BRT's (x3) 420 VGX

HLA and DIS Gateway

MAXVUE Host Indigo 2

MAXVUE IMAGE GENERATOR

15" CRT

10"CRT

PROGRAMMABLE PUSHBUTTONS

KEYPAD

HAND-CONTROLLER

PUSHBUTTONS

projector

projector

HELMET

PROGRAMMABLE PUSHBUTTONS

10"CRT

15" CRT

10"CRT

KEYPAD

HAND-CONTROLLER

PUSHBUTTONS

Scramnet
Ethernet
Video

MESEF Architecture

MESEF HOST COMPUTER
Power Series Server (460S)

TSD
VGX

ITEMS
VGX

HLA and DIS
Gateway

MAXVUE
Host
Indigo 2

MAXVUE
IMAGE
GENERATOR

26" CRT

HAND-
CONTROLLERS
(L/R)

EL PANELS
(L/R)

projector

projector

MAXVUE
HELMET

Scramnet	━━━
Ethernet	—
Video	– – ··
Fiber Optic	═══

Introduction to CAMELEON

- **Computer Aided ModELing and Equipment evaluatiON facility (CAMELEON) participating agencies:**
  - US Army Research, Development and Engineering Centers (RDECs)
- **Federation sponsors' objective:**
  - Provide an advanced research, development and engineering simulation test bed with full mission capabilities to support Army RDA initiatives in concept exploration, war fighting effectiveness, engineering simulation, and design engineering
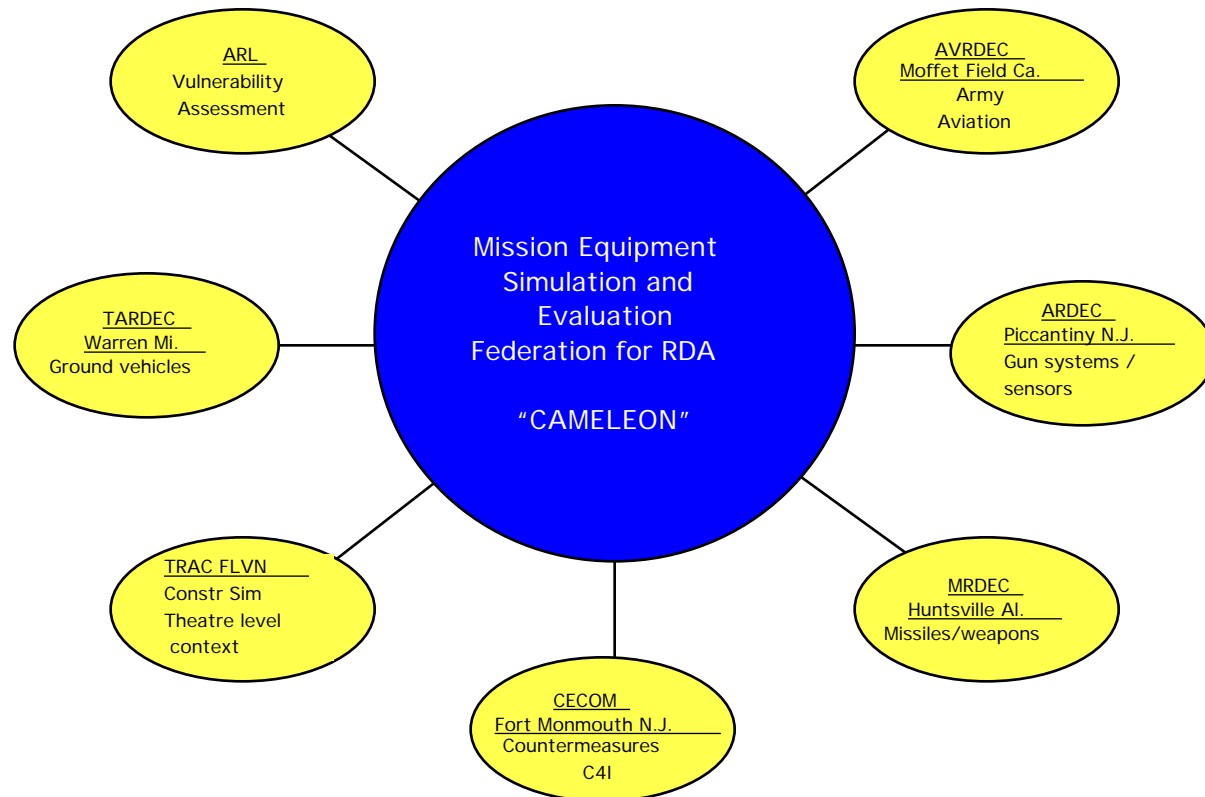
Introduction (con't)

- **What is the value of doing distributed networking in the RDEC community?**

  - **Re-use of existing, validated simulations developed at considerable government expense**

  - **Impractical to build a monolithic simulation**

    - **Need a composable approach**

  - **Not everyone need participate at the same time**

    - **RDECs must work both in collaboration and independently to fulfill their missions**

Introduction (con't)

- System development and evaluation cannot be limited to stand-alone testing
  - Must consider overall mission effectiveness
  - Integrated nature of the next generation weapon system platform
- Make use of more affordable/faster wide area communications infrastructure

- **HLA provides an attractive framework for attempting to build a distributed simulation for RDA...**

Candidate Federates

ARL
Vulnerability
Assessment

AVRDEC
Moffet Field Ca.
Army
Aviation

TARDEC
Warren Mi.
Ground vehicles

ARDEC
Piccantiny N.J.
Gun systems /
sensors

Mission Equipment
Simulation and
Evaluation
Federation for RDA

"CAMELEON"

TRAC FLVN
Constr Sim
Theatre level
context

MRDEC
Huntsville Al.
Missiles/weapons

CECOM
Fort Monmouth N.J.
Countermeasures
C4I

CAMELEON Federates (con't)

- **Candidate federate roles in a combined arms exercise:**
  - **AvRDEC - aviation model**
  - **MRDEC - missile model, data collection/analysis tool**
  - **ARDEC - gun system models**
  - **TARDEC - ground vehicles**
  - **CECOM - ECM, intel and communications**
  - **ARL - vulnerability assessment**
 - **TRAC FLVN - scenario/mission context**

CAMELEON Federates (con't)

- **Target demonstrations (experiment context) will use validated missions/scenarios developed for the Rotorcraft Pilot's Associate ATD Warfighting Effectiveness Evaluations**
  - **Based on TRADOC High Resolution (HR) scenarios:**
    - **Reconnaissance (from HR 24)**
    - **Attack (from HR 24)**
    - **Combined arms attack (from HR 45)**
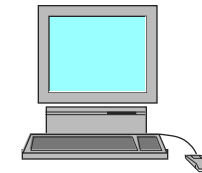   - **Special operations/deep attack (from HR 49/50)**

Example Scenario

Air Vehicle/MEP System
AvRDEC

Gun System
ARDEC

Electronic Countermeasures
CECOM
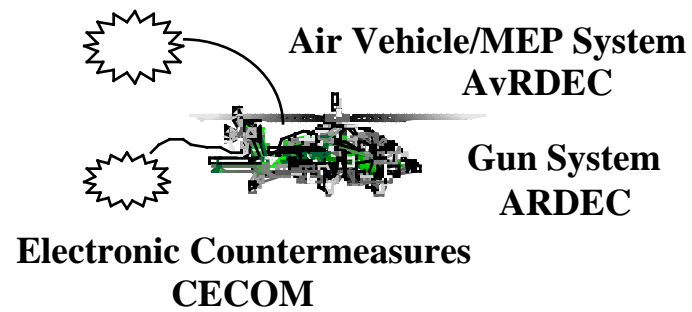
Tactical Scenario
TRAC FLVN
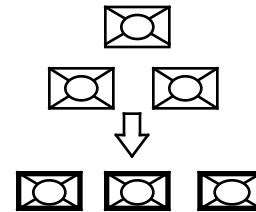
HELLFIRE Flight Dynamics
MRDEC

Battle Damage Assessment
ARL

Threat Radar Performance
CECOM

Mounted Operations
TARDEC
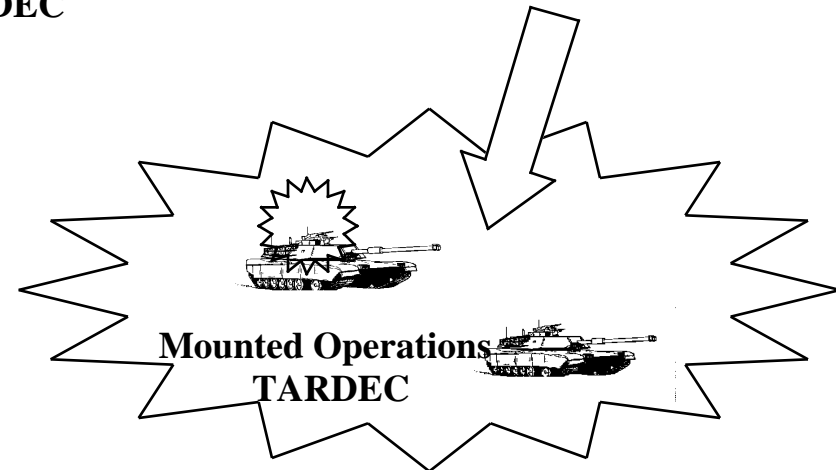
Example Scenario (con't)
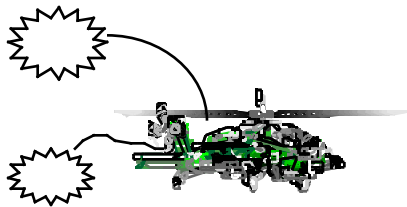
- **AvRDEC**
  - **Target acquisition**
  - **Pilot brings aircraft into launch constraints**
  - **Trigger pull**

- **MRDEC**
  - **Missile dynamics and control**
  - **Data Collection and Analysis Tool (DCAT)**

Example Scenario (con't)
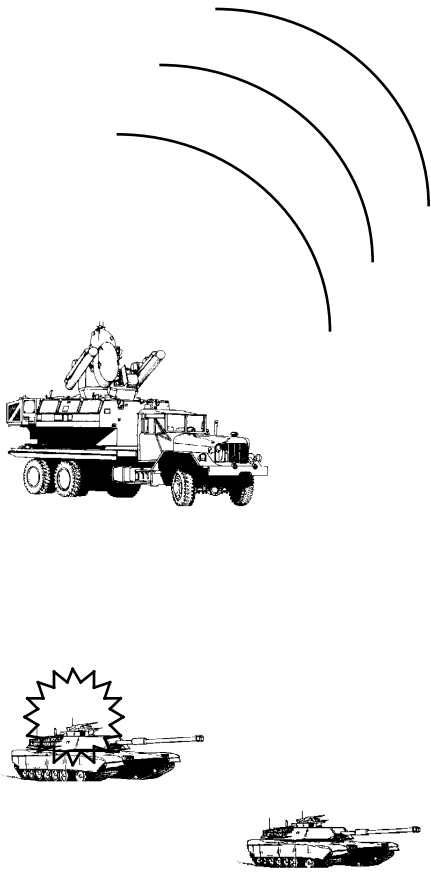
- **CECOM**
  - **Electronic countermeasures**
  - **Threat radar system simulation**
- **TARDEC**
  - **Blue and red ground forces including human-in-the-loop simulators at the VETRONICS facility**
- **ARDEC**
  - **Gun system simulation**

Example Scenario (con't)
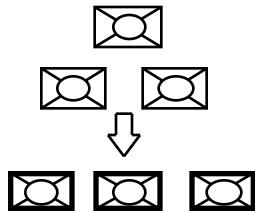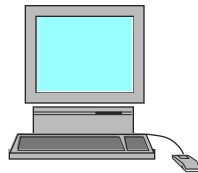
- **ARL**
  - **Vulnerability assessment of bullet, rocket and missile engagements**

- **TRAC FLVN**
  - **Linkage to Eagle constructive simulation for large entity count combined arms battle**

Federation Development Plan

- **RDA federation will be implemented using a phased approach**
  - **First, develop and test software for the federation on a central platform**
  - **Next, integrate federates one by one**
- **Advantages of phased approach:**
  - **Development is done in a controlled and coordinated fashion between RDA participants**
  - **Incremental HLA functionality using build-test-build approach**
  - **Facilitates design interoperability**

Fed Development Plan (con't)

```
┌─────────────────────┐
│ Non HLA Legacy/     │
│ External Models     │
└─────────┬───────────┘
          │
┌─────────┴───────────┐        ┌─────────────────────┐
│ Models/RTI          │        │ HLA Compliant       │
│                     │        │ Legacy/External     │
│ Interface Translator│        │ Models              │
└─────────┬───────────┘        └──────────┬──────────┘
          │                               │
┌─────────┴───────────────────────────────┴──────────┐
│                      RTI                            │
└──┬──────────┬──────────────┬─────────────┬──────────┘
```

Internal Models	Station Cockpit	Configuration Manager	CGF	Existing AMSIM Facility

ASE
AFC
Navigation
TAS
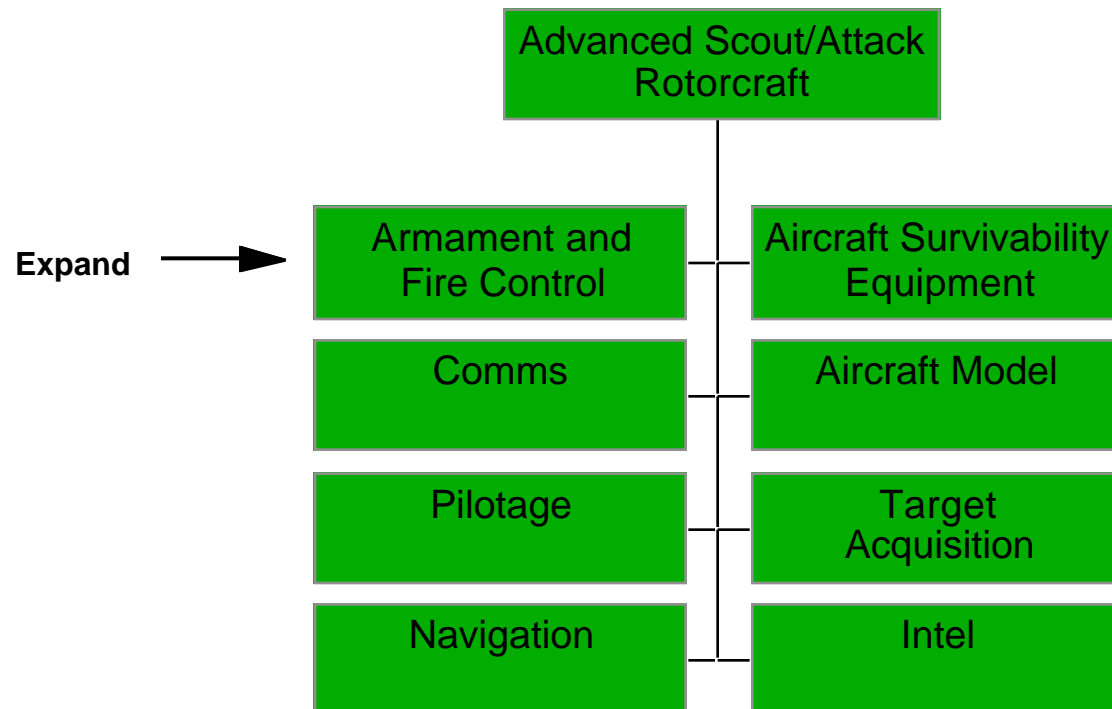Flight
Intel/Comms

Visual Display
Helmet
Pilot stick input
Reconfig Instr Panels
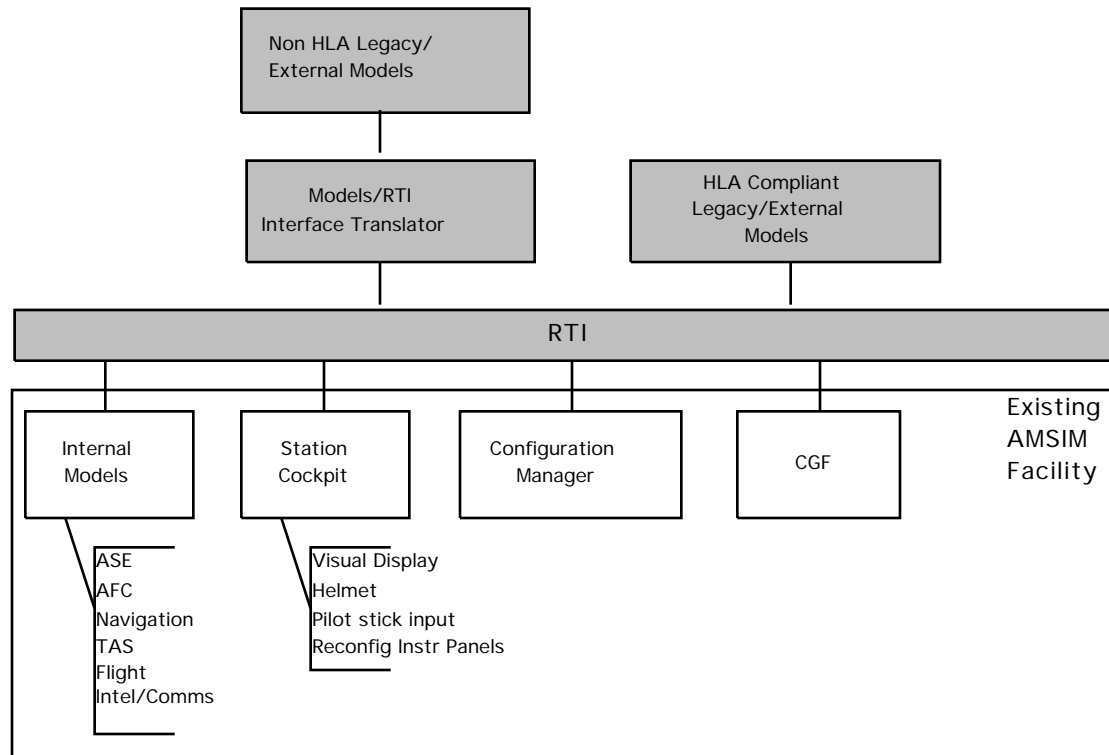
- **Selected internal components will be made to communicate via the RTI**
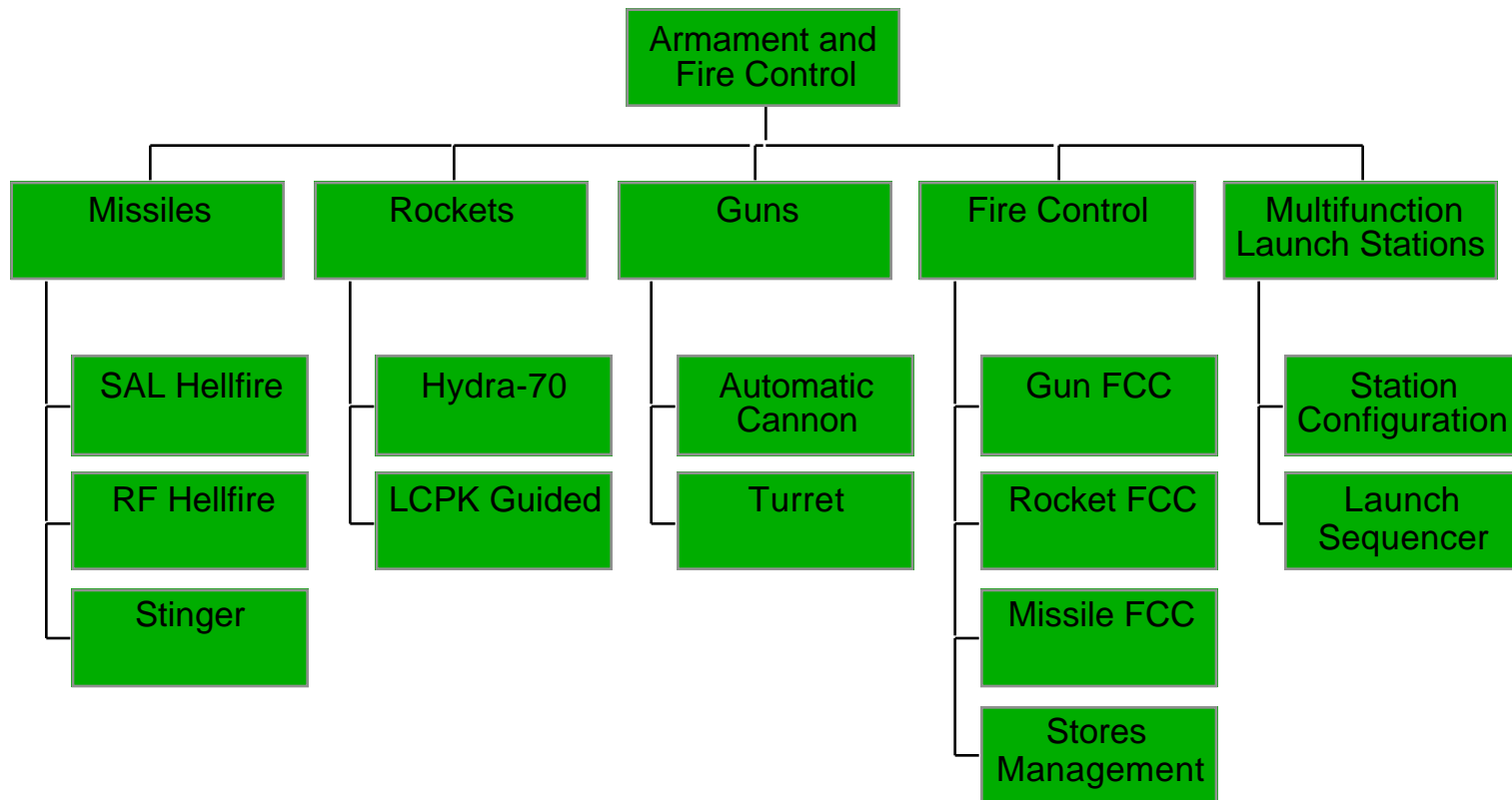
  - **Demands a composable simulation architecture...**

CAMELEON Simulation Environment

Level 1 Object Decomposition (Partial)

```
                    ┌──────────────────────┐
                    │ Advanced Scout/Attack│
                    │      Rotorcraft      │
                    └──────────────────────┘
                                │
   ┌──────────────────┐                  ┌──────────────────────┐
Expand ─▶│ Armament and │                │ Aircraft Survivability│
   │   Fire Control   │                  │      Equipment       │
   └──────────────────┘                  └──────────────────────┘

   ┌──────────────────┐                  ┌──────────────────────┐
   │      Comms        │                 │    Aircraft Model     │
   └──────────────────┘                  └──────────────────────┘

   ┌──────────────────┐                  ┌──────────────────────┐
   │     Pilotage      │                 │        Target         │
   │                   │                 │      Acquisition      │
   └──────────────────┘                  └──────────────────────┘

   ┌──────────────────┐                  ┌──────────────────────┐
   │    Navigation     │                 │         Intel         │
   └──────────────────┘                  └──────────────────────┘
```

CAMELEON Simulation Environment (con't)

Level 2 Object Decomposition (Partial)

Armament and Fire Control

- **Missiles**
  - SAL Hellfire
  - RF Hellfire
  - Stinger
- **Rockets**
  - Hydra-70
  - LCPK Guided
- **Guns**
  - Automatic Cannon
  - Turret
- **Fire Control**
  - Gun FCC
  - Rocket FCC
  - Missile FCC
  - Stores Management
- **Multifunction Launch Stations**
  - Station Configuration
  - Launch Sequencer

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CAMELEON Simulation Environment (con't)

- **Considerations in designing a composable architecture for a legacy simulator**
  - **How data is exchanged between subsystems**
    - **e.g. Use of RTI or legacy method**
  - **How data is stored**
    - **e.g. Partitioning/access of shared memory**
  - **Simulation executive**
    - **Sequencing and timing**
      - **e.g. Real-time dispatcher**

CAMELEON Simulation Environment (con't)

- **Mix of event based and time step simulation**
    - **e.g. Support external control of state transitions and simulation clock**
- **Configuration management**
    - **e.g. Version control and switching between internal/external models**
- **Data collection**
    - **e.g. Data access for external models**
- **Development and testing tools**
    - **e.g. Real-time debugger, time profile utility**

HLA Technical Issues Addressed by CAMELEON

- **Real world, rigorous test of simulation interoperability and re-use using HLA**

- **Level of effort and procedures required to make legacy simulations HLA compliant**

- **Development and evaluation of automated tools for federation design, execution, testing, and monitoring**

- **Federation Object Models (FOMs)**
  - **Process of achieving consensus on content**
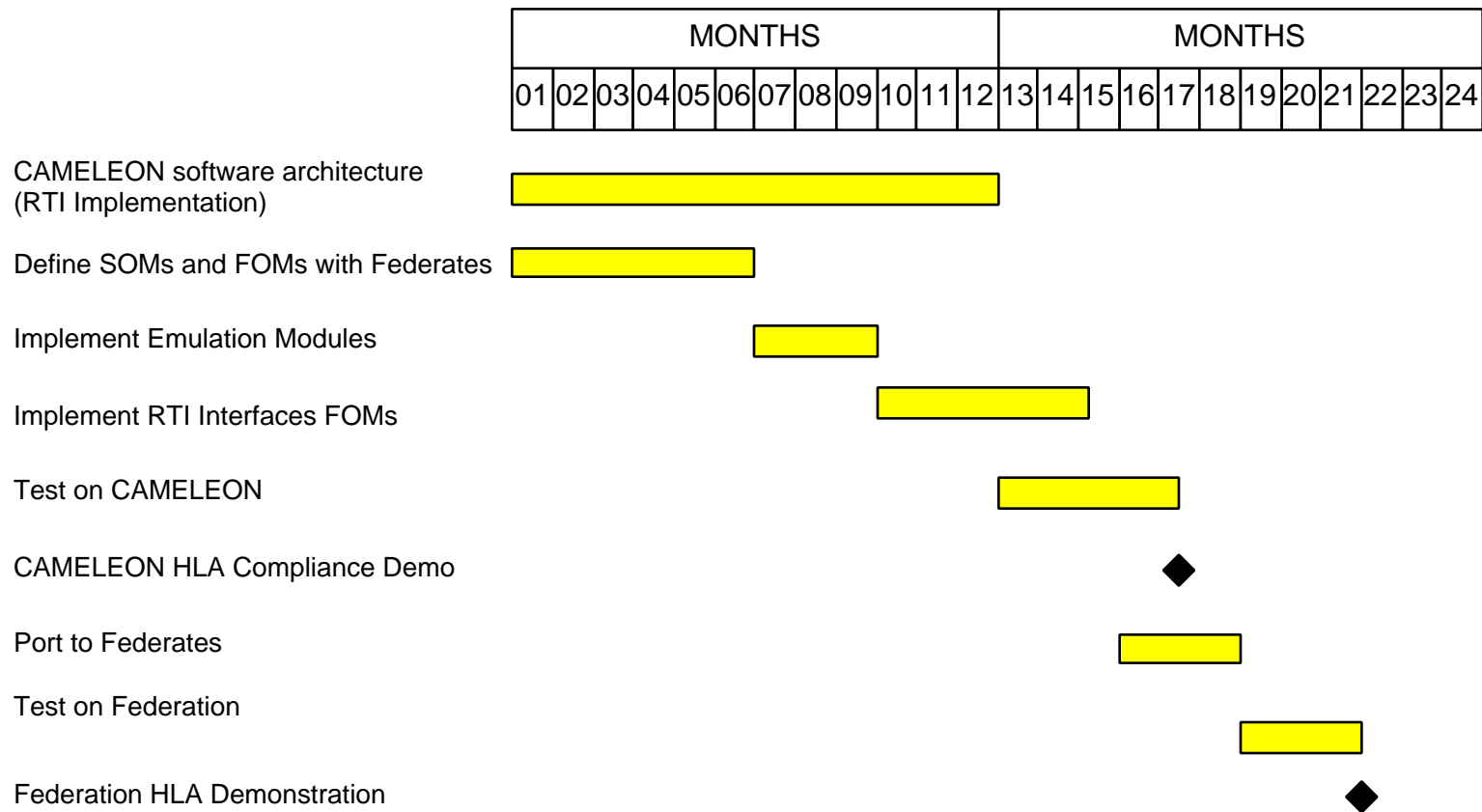 - **Reference FOMs**

- **RTI performance issues**

HLA Technical Issues Addressed by CAMELEON (con't)

- **Runtime Infrastructure (RTI) services of particular interest:**
  - Ownership Management for transferring responsibility for parts of the simulation between federates
    - e.g., Federate A launches weapon, Federates B flies it out, Federate C performs damage assessment
  - Time Management for slow time, real time, fast time and event based simulation execution
  - Data Distribution Management to maintain data traffic at reasonable levels within available bandwidth

CAMELEON Program Goals

- **CAMELEON is part of a proposed five year joint US - Canada program under the Defense Development Share Program**
  - **Initial emphasis will be to attain HLA compliance for US participants by FY 1999**
  - **Integrate Canadian federates as appropriate to target projects (consideration for security restrictions)**

RDA Federation Implementation Time Line

	MONTHS												MONTHS											
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24

CAMELEON software architecture (RTI Implementation)

Define SOMs and FOMs with Federates

Implement Emulation Modules

Implement RTI Interfaces FOMs

Test on CAMELEON

CAMELEON HLA Compliance Demo

Port to Federates

Test on Federation

Federation HLA Demonstration

Pilot Projects

- **Joint FAA/Army/NASA (JFAN) Federation**
  - **Federal Aviation Administration**
    - **William J. Hughes Technical Center, Atlantic City, NJ**
  - **US Army**
    - **AMSIM, Ames Research Center, Moffett Field, CA**
  - **NASA**
    - **Aeronautical Test and Simulation Directorate, Ames Research Center, Moffett Field, CA**
  - **Demonstration planned for winter 97-98**
    - **Simulate realistic traffic densities in one arrival and one or more feeder sectors at KSFO**

Pilot Projects (con't)

- **AMSIM, TARDEC and TRAC FLVN lead-in work for CAMELEON**
  - Understand the technical challenges of using the HLA technology in a basic RDA application
  - Provide a concrete goal to drive software development leading to HLA compliance of the participating federates
  - Foster a working relationship with other government simulation laboratories
  - Demonstration planned for winter 97-98

Summary

- **CAMELEON will be a complete platform for RDA mission equipment simulation and evaluation**
  - **Facilitate RDEC simulator interoperability and re-use of legacy models**
- **CAMELEON products:**
  - **Flexible, comprehensive RDA development test bed**
  - **Test and evaluation of HLA related tools**
  - **Reference FOMs for RDA community**